(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 352 468 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication of patent specification: **07.12.94** (51) Int. Cl.5: **B41J 2/16**

(21) Application number: **89111168.4**

(22) Date of filing: **20.06.89**

(54) Method for producing an orifice plate for an ink jet recording head.

(30) Priority: **21.06.88 JP 151083/88**
20.06.89 JP 155581/89

(43) Date of publication of application:
31.01.90 Bulletin 90/05

(45) Publication of the grant of the patent:
07.12.94 Bulletin 94/49

(84) Designated Contracting States:
DE ES FR GB IT

(56) References cited:
US-A- 4 047 186

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EP 0 352 468 B1

Description

The present invention relates to a method for producing an orifice plate according to the preamble of claim 1.

Such an orifice plate in which through-holes defining orifices or discharge ports for discharging the ink of a recording head is mounted on an ink jet recording apparatus used in a copying machine, a facsimile apparatus, a word processor, a printer for the output of a computer, a printer for video output or the like and positioning apertures for effecting the positioning of the recording head in the recording apparatus are provided with good arrangement accuracy, and to an ink jet recording head using said orifice plate as well as to an ink jet recording apparatus carrying said head thereon.

An ink jet recording apparatus adopts a method of discharging ink as recording liquid, forming flying liquid droplets and causing the ink to adhere to a recording medium such as paper to thereby accomplish recording. Systems for forming ink droplets in such ink jet recording apparatus include a system generally called the continuous type wherein pressurized ink is made into a liquid droplet stream by imparting vibrations thereto by a piezo-electric element, charges are imparted to the liquid droplet stream by an electrode and only the necessary one of the liquid droplets is deflected to thereby accomplish recording, a system called the on-demand type which utilizes, for example, a pressure change in a liquid path caused by the deformation of a piezo-electric element, and a system which uses a heat generating element as an ink discharge energy generating member as in the system as described in US-A-4,723,129 (Endo et al.) or US-A-4,740,796 (Endo et al.) wherein a heat generating element is provided in a liquid path, ink is suddenly heated and a liquid droplet is discharged by the force of the resultant bubble.

Among the above-described ink jet recording systems, particularly the system using a heat generating element as a discharge energy generating member has advantages such as the ease with which orifices for discharging ink forming ink droplets is made highly dense with good accuracy, and the possibility of highspeed recording.

On the other hand, as the typical printing systems in the ink jet recording apparatus, there are the serial type in which use is made of a recording head having orifices arranged in a spacing narrower than the width of an image to be recorded and the recording head is scanned relative to a recording medium such as paper to thereby accomplish recording line by line, and the full line type in which orifices are arranged in the main scanning direction, for example, over the full width of an image to be recorded and a recording head and a recording medium are moved relative to each other in the sub-scanning direction to thereby record one line substantially at a time.

Of the above-described two printing systems, full line type printers are being actively developed from the viewpoint that they can sufficiently meet the desire for high-speed recording. Moreover, in this full line type printing system, a number of recording heads having orifices arranged therein are juxtaposed to constitute a recording apparatus, whereby it becomes possible to accomplish recording in a larger area at a time and further, attention has been paid to this printing system from the viewpoint that by the use of recording heads in which the arrangement density of orifices are enhanced, for example, the requirement for high-speed recording of colored images of high density and high quality can be met easily.

However, in a recording head in which are arranged a plurality of heads each having several tens to several hundreds or several thousands of discharge port, particularly, full line type heads, the influence of the arrangement accuracy of all the orifices upon the image recording accuracy appears particularly remarkably and therefore, it is necessary to make not only the arrangement accuracy of the orifices influenced by the arrangement of the recording heads, but also the arrangement accuracy of the orifices influenced by the relative positional relationship among the plurality of recording heads sufficient.

The US-A-4,477,823 discloses a generic method for producing an orifice plate. The US-A-4,477,823 (Matsufuji et al.) or the US-A-4,499,478 (Matsufuji et al.) disclose four recording heads 1 of the full line type in each of which fourteen ink jet elements 1a shown in Figure 1A of the accompanying drawings having a number of orifices (not shown) arranged at a predetermined density are arranged in staggered relationship are juxtaposed as shown in Figure 1B of the accompanying drawings. According to our experiment, it has been found that when the positions of the orifices in the direction of arrangement thereof and the degree of parallelism of the recording heads 1 are taken into consideration, the arrangement accuracy of at least ± 1/4 dot pitch (for example, ± 30 µm if the arrangement density of the orifices is 8 dot/mm, or ± 15 µm if said arrangement density is 16 dot/mm) is required in installing the recording heads 1.

However, the positioning of the recording heads in such an apparatus is accomplished by discretely attached fixing jigs 2 and 3 to the body of each recording head 1 as shown in Figure 1B, and providing positioning pins 4 and 5 at the locations of the recording apparatus whereat the recording heads 1 are installed.

More particularly, as shown in the enlarged perspective view of Figure 1A, the degree of parallelism of all heads 1 and the arrangement accuracy (dimension A) of the orifices are determined by positioning holes 6 and 7 formed in the fixing jigs 2 and 3.

However, the fixing jigs 2, 3 and the positioning pins 4, 5 are made solely by machining, and for example, to obtain the very precise arrangement accuracy of recording heads such as ± 30 µm or ± 15 µm as mentioned above, the machining accuracy substantially approximate to a limit is required for the making of these jigs and pins, and this has caused the cost of the recording heads to rise remarkably.

That is, in a recording apparatus having a plurality of recording heads of the conventional full line type, even if the recording head body has been made at no small cost by the use of a technique such as photolithography which enables fine working at high accuracy, it has been a positioning method which is low in mass productivity and costly in working and assembling mechanical parts highly accurately and which can never be said to be efficient.

As a result of numerous experiments we have carried out repetitively, we have found that the above-noted problem of positioning also affects the quality of recorded images such as the ink discharge characteristic or the adherence of ink droplets to desired accurate locations on a recording medium. Further, as a result of experiments we have carried out additionally, we have also found that the quality of images in not only the full line type heads but also the heads used in the serial system is affected by the above-described positioning of the discharge ports.

It is the object of the present invention to further develop a method for producing an orifice plate according to the preamble of claim 1 such that an exact ink discharge operation is guaranteed while a simple structure is maintained.

This object is achieved by the features indicated in the characterizing portion of claim 1.

Advantageous further developments are set out in the dependent claims.

According to the present invention the orifice plate produced in such a manner enables a great reduction in the manufacturing cost of a recording head, and a recording head using said plate member, as well as an ink jet recording apparatus carrying said head thereon.

With the method of the present invention an orifice plate is producable which can easily enhance the arrangement accuracy of a plurality of orifices in an ink jet recording apparatus, and a recording head using said orifice plate, as well as an ink jet recording apparatus carrying said head thereon.

Positioning apertures for use when a recording head using the orifice plate is mounted on a recording apparatus are provided with good accuracy and the desired arrangement accuracy of orifices provided in the recording head can be easily obtained by the use of said positioning apertures, and a recording head using said orifice plate, as well as an ink jet recording apparatus carrying said head thereon.

The positioning apertures are formed correspondingly to the arrangement of orifices during the formation of the orifice plate, i.e., when through-holes providing the orifices are provided in a plate-like member.

The orifice plate is producable in which when orifices are to be formed by the use of a method using photolithography, a pattern corresponding to positioning apertures and a pattern corresponding to orifices are formed in an exposure mask at a time with predetermined accuracy as will be described later, whereby the orifice plate is manufactured by effecting the ordinary exposure, development and etching process.

By the method of claim 1 a recording head is obtainable whose positioning apertures are automatically disposed in an orifice plate with good accuracy and therefore which eliminates the non-mass-productive process of discretely making positioning jigs by machining and attaching them to the recording head body with good accuracy, and an ink jet recording apparatus carrying said head thereon.

An ink jet recording head can be constructed by the use of an orifice plate formed with positioning apertures, whereby eliminating the necessity of using jigs which require high machining accuracy and using a skillful apparatus assembling technique, and which is high in mass productivily and low in cost and enables good arrangement accuracy of orifices to be achieved, and an ink jet recording apparatus in which the positioning of said head can always be easily achieved with good accuracy.

Figure 1A is a schematic perspective view showing the conventional construction of a full line type recording head.

Figure 1B is a schematic perspective view showing the construction of the vicinity of the heads of an ink jet recording apparatus having a plurality of full line type recording heads.

Figure 2 is a schematic perspective view showing a recording head according to a first embodiment of the present invention.

Figures 3A - 3D are schematic views for illustrating the process of manufacturing an orifice plate according to the present invention.

Figure 4 is a schematic perspective view for illustrating the construction of an ink jet recording apparatus according to the present invention.

Figure 5 is a schematic perspective view for illustrating the construction of a recording head according to a second embodiment of the present invention.

Figure 6 is a schematic perspective view for illustrating the construction of a recording head according to a third embodiment of the present invention.

A preferred embodiment produced by the method according to the invention may be a plate member formed with a plurality of discharge ports and having a construction in which positioning portions for effecting the positioning relative to an apparatus are provided, and although the shape of the positioning portions is not specifically limited, a circular or polygonal closed through-hole or cut-in portion is preferable. Above all, it is preferable that positioning portions be provided at the opposite ends of the plate member and one of them be made into a circular aperture and the other positioning portion be made into a tapered cut-in portion or an elliptical aperture and fine adjustment can be accomplished by said other positioning portion with said circular aperture as a reference position. The material of the plate member is suitably selected from among those will not cause deformation or degeneration of the discharge ports and the positioning portions by ink used or the like. The material may be, for example, a metal material such as nickel or stainless steel, or a metal material surface-treated so that it may not be deteriorated by ink, or a hard resin material. It will be more preferable if the outer surface of the plate member in which the discharge ports are formed is subjected to ink-repelling surface treatment.

Also, the shape and number of the discharge ports may be a circle, an ellipse or a polygon corresponding at one to one to a discharge energy generating element generating discharge energy, or one discharge port may correspond to a plurality of discharge energy generating elements and the shape thereof may be a circle, an ellipse, a polygon or a slit-like shape.

In short, the plate member may be of a construction which can achieve the objects of the present invention, and is not restricted to embodiments hereinafter described.

A first embodiment of the present invention will hereinafter be described in detail with reference to the drawings.

Figure 2 is a perspective view of an example of a full line type ink jet recording head using the orifice plate of the present invention.

In this recording head 11, the orifice plate 12 is joined to the front face of the head body, and the opposite end portions of the orifice plate 12 having a number of orifices 13 (the central ones thereof, being not shown) arranged therein in a row are projected from the side surfaces of the body of the recording head 11, and positioning apertures 14 as positioning means are formed in these opposite end portions.

These positioning apertures 14 have already been formed accurately correspondingly to the arrangement of the orifices 13 during the formation of the orifice plate 12 and therefore, if the positioning of the recording head in the recording apparatus is done by the use of these positioning apertures 14, high arrangement accuracy of the orifices 13 in the apparatus will be automatically obtained.

Moreover, if, for example, these positioning apertures 14 are formed at a time during the formation of the orifice plate 12 by the photolithography as described hereinafter, highly accurate positioning apertures 14 can be formed very easily without the addition of any special process.

When the orifice plate 12 was to be formed by the use of the process as shown, for example, in Figures 3A - 3D, a photoresist layer 15 was provided on the surface of the plate member 12 (Figure 3A). This was exposure-processed through a mask 16 for exposure as shown in Fgiure 3B. On this mask 16, a patterns corresponding to the positioning apertures 14 is provided with good accuracy in a predetermined positional relation with a pattern corresponding to the orifices 13. Thereafter, the ordinary developing and etching steps as shown in Figures 3C and 3D were carried out, whereby there could be obtained the orifice plate of the present invention in which the orifices 13 and the positioning apertures 14 were formed at a time.

The orifice plate thus formed has arranged thereon electro-thermal converting members 17 as ink discharge energy generating members as shown, for example, in Figure 4, and a recording signal is supplied from a drive circuit 18 to the electro-thermal converting members 17, which thus generate heat energy available for the discharge of ink.

At this time, a liquid path provided in the recording head 11 is filled with the ink supplied from an ink tank 19, and the imparted heat energy acts on the ink and due to the growth and contraction of a bubble created by the film boiling phenomenon, the ink is discharged from the discharge ports 13 to thereby form flying droplets. These droplets adhere to the surface of a recording medium P conveyed to a position opposed to the discharge ports 13 by conveying rollers 20 and 21 and thus, image recording by a dot pattern is accomplished.

According to this construction, the positioning of the discharge ports is accomplished by the positioning reference being taken by a positioning aperture 14-1 with the aid of the positioning portion of the orifice plate and holding means for holding the same, and being determined by a finely adjustable elliptical second positioning aperture 14-2. Accordingly, the positions of the discharge ports 13 from which the ink is finally discharged do not fluctuate and therefore, good recording is accomplished.

Figure 5 is a schematic perspective view showing a recording head according to a second embodiment of the present invention.

This recording head 111 is a head of the type which discharges ink in a direction intersecting a heat generating surface on which electro-thermal converting members 117 are provided. This head 111 is of a construction in which an orifice plate 112 provided with positioning apertures 114-1 and 114-2 is joined to a support member 120 formed, for example, of Si and provided with an ink supply hole 118 for supplying ink to an ink chamber 122 from an ink tank, not shown, similar to the ink tank 19 shown in Figure 4, through a barrier 119 formed of a hardened film of photosensitive resin or the like as a liquid path forming member and surrounding each electro-thermal converting member 117 from the three sides thereof, and a wall 121 formed of a hardened film of photosensitive resin and forming an ink chamber 122.

A method of manufacturing the orifice plate shown in Figure 5 will now be described.

A plate-like member formed of Ni for forming the orifice plate was first prepared. Also, a rigid large punching mold formed with protrusions corresponding to the size, shape and arrangement pitch of discharge ports to be formed and to positioning apertures was prepared.

The plate-like member was then fixed to the support member of a punching machine, the mold was urged thereagainst and through-holes corresponding to the protrusions were formed in the plate-like member by a shearing force.

Thorn-like protrusions created near the through holes were polished to thereby obtain good planarity and comple the orifice plate.

In a recording head having the orifice plate thus obtained, the positioning apertures of the recording head are already provided in the orifice plate and therefore, there is no necessity of adding positioning jigs as in the prior-art recording head and moreover, even when the operation as described above is repeated to manufacture a number of recording heads, the dimension A shown, for example, in Figure 5, can always be obtained uniformly and very easily and thus, the arrangement accuracy of the recording heads is greatly improved.

Figure 6 is a schematic perspective view showing a recording head according to a third embodiment of the present invention.

In such a construction, four electro-thermal converting members share one discharge slit and therefore the working of the slit is easy, but a portion in the slit which discharges an ink droplet is defined substantially by the slit and a fluid resistance element which will be described later and therefore, the positioning as by the present invention becomes necessary for obtaining good images.

The present embodiment is substantially similar in construction to the above-described second embodiment, and differs from the latter in that as described above, one slit corresponds to a plurality of electro-thermal converting members and droplets forming a plurality of dots are discharged from one slit.

The reference numeral 220 designates a glass substrate, on which is provided a heat generating resistance layer, on which are disposed patterned Al electrode 241, whereby electro-thermal converting members 217 are constituted. A protective layer formed of SiO_2 is provided on the electro-thermal converting members 217 and electrodes 241 to thereby constitute a heater board.

Fluid resistance elements 219 are disposed on the opposite sides of each electro-thermal converting member 217, whereby pressure waves can be prevented from being propagated in the lengthwise direction of the slit, i.e., the direction of arrangement of the electro-thermal converting members.

As regards pressure waves in the horizontal direction, the interference therebetween is prevented by the use of openings 230.

That is; as regards also the openings 230 provided in each electro-thermal converting member 217 to prevent the interference between the pressure waves and to exhaust created minute bubbles, they are rightly positioned by the construction of the present invention to thereby display the effect thereof at its maximum.

The reference numeral 221 denotes a spacer which keeps the spacing between the slit plate 212 and the substrate 220 constant and defines a liquid path.

The recording head 211 is fixed to the head supporting means (not shown) of the apparatus with the aid of positioning apertures 214, whereby positioning of the head is accomplished.

As described above, according to the present invention, during the formation of the orifice plate, the positioning apertures of the recording head are formed with good accuracy simultaneously with the through-holes which provide the orifices and therefore, accurate positioning of the recording head

using the orifice plate is simplified.

Also, since the positioning apertures in the orifice plate can be easily formed without the addition of any special high-degree process, an ink jet recording head having highly accurate and inexpensive positioning apertures can be obtained with ease.

Claims

1. A method for producing an orifice plate (12, 112, 212) provided with openings (13, 113, 213, 230) capable of defining discharge ports for discharging the ink of a recording head (11, 111, 211) carried on an ink jet recording apparatus comprising the step of
providing positioning portions (14, 14-1, 14-2, 114-1, 114-2, 214) usable for positioning said discharge ports relative to said ink jet recording apparatus, and
characterized by
forming said openings (13, 113, 213, 230) and said positioning portions (14, 14-1, 14-2, 114-1, 114-2, 214) simultaneously in a predetermined positional relation by photolithography.

2. A method for producing an orifice plate (12, 112, 212) according to claim 1,
characterized in that
said positioning portions (14, 14-1, 14-2, 114-1, 114-2, 214) are provided in portions of said orifice plate (12, 112, 212) which protrude from the body of said recording head (11, 111, 211).

3. A method for producing an orifice plate (12, 112, 212) according to any of claims 1 or 2,
characterized in that
said positioning portions (14, 14-1, 14-2, 114-1, 114-2, 214) are provided at opposite ends of said orifice plate (12, 112, 212) with the discharge ports interposed therebetween.

4. A method for producing an orifice plate (12, 112, 212) according to any of claims 1 to 3
characterized in that
the shapes of the positioning portions (14, 14-1, 14-2, 114-1, 114-2, 214) differ from each other.

5. A method for producing an orifice plate (12, 112, 212) according to any of claims 1 to 4
characterized in that
said positioning portions (14, 14-1, 14-2, 114-1, 114-2, 214) are provided as cut-away portions

6. A method for producing an orifice plate (12, 112, 212) according to any of claims 1 to 5
characterized in that
said positioning portions (14, 14-1, 14-2, 114-1, 114-2, 214) are provided as through-holes.

7. A method for producing an orifice plate (12, 112, 212) according to any of claims 1 to 6,
characterized in that
said openings (113, 213) are provided slit-shaped.

8. A method for producing an orifice plate (12, 112, 212) according to any of claims 1 to 7,
characterized in that
said openings (13, 113, 213, 230) are provided corresponding to a plurality of discharge energy generating elements (117, 217).

9. A method for producing an orifice plate (12, 112, 212) according to any of claims 1 to 8,
characterized in that
said discharge ports are further provided with a path wall member (119, 121, 219, 221) positioned below the orifice plate (12, 112, 212).

Patentansprüche

1. Verfahren für die Herstellung einer Düsenplatte (12, 112, 212), welche mit Öffnungen (13, 113, 213, 230) vorgesehen ist, welche Ausstoßöffnungen für den Tintenausstoß eines Druckkopfs (11, 111, 211), der an einer Tintenstrahlaufzeichnungsvorrichtung getragen wird, definieren können, und den folgenden Schritt aufweist:
Schaffung von Positionierabschnitten (14, 14-1, 14-2, 114-1, 114-2, 214), welche für die Positionierung der Ausstoßöffnungen relativ zur Tintenstrahlaufzeichnungsvorrichtung verwendet werden können, und
gekennzeichnet durch
die gleichzeitige Bildung der Öffnungen (13, 113, 213, 230) und der Positionierabschnitte (14, 14-1, 14-2, 114-1, 114-2, 214) mittels Lithographie in einer vorbestimmten Lagebeziehung.

2. Verfahren für die Herstellung einer Düsenplatte (12, 112, 212) nach Anspruch 1,
dadurch gekennzeichnet, daß
die Positionierabschnitte (14, 14-1, 14-2, 114-1, 114-2, 214) in Abschnitten der Düsenplatte (12, 112, 212) vorgesehen sind, welche von dem Körper des Druckkopfes (11, 111, 211) hervorstehen.

3. Verfahren für die Herstellung einer Düsenplatte (12, 112, 212) nach einem der Ansprüche 1 oder 2,
dadurch gekennzeichnet, daß

die Positionierabschnitte (14, 14-1, 14-2, 114-1, 114-2, 214) an gegenüberliegenden Enden der Düsenplatte (12, 112, 212) vorgesehen sind, wobei die Ausstoßöffnungen dazwischengelagert sind.

4. Verfahren für die Herstellung einer Düsenplatte (12, 112, 212) nach einem der Ansprüche 1 bis 3,
dadurch gekennzeichnet, daß
sich die Formen der Positionierabschnitte (14, 14-1, 14-2, 114-1, 114-2, 214) voneinander unterscheiden.

5. Verfahren für die Herstellung einer Düsenplatte (12, 112, 212) nach einem der Ansprüche 1 bis 4,
dadurch gekennzeichnet, daß
die Positionierabschnitte (14, 14-1, 14-2, 114-1, 114-2, 214) als Hinterschneidungsabschnitte vorgesehen sind.

6. Verfahren für die Herstellung einer Düsenplatte (12, 112, 212) nach einem der Ansprüche 1 bis 5,
dadurch gekennzeichnet, daß
die Positionierabschnitte (14, 14-1, 14-2, 114-1, 114-2, 214) als Durchgangslöcher vorgesehen sind.

7. Verfahren für die Herstellung einer Düsenplatte (12, 112, 212) nach einem der Ansprüche 1 bis 6,
dadurch gekennzeichnet, daß
die Öffnungen (113, 213) schlitzförmig sind.

8. Verfahren für die Herstellung einer Düsenplatte (12, 112, 212) nach einem der Ansprüche 1 bis 7,
dadurch gekennzeichnet, daß
die Öffnungen (13, 113, 213, 230) in Übereinstimmung mit einer Vielzahl von Ausstoßenergieerzeugungselementen (117, 217) vorgesehen sind.

9. Verfahren für die Herstellung einer Düsenplatte (12, 112, 212) nach einem der Ansprüche 1 bis 8,
dadurch gekennzeichnet, daß
die Ausstoßöffnungen ferner mit einem unter der Düsenplatte (12, 121, 212) angeordneten Durchgangswand-Element (119, 212, 219, 221) vorgesehen sind.

Revendications

1. Procédé pour produire une plaque (12, 112, 212) à orifices pourvue d'ouvertures (13, 113, 213, 230) capables de définir des orifices de décharge pour décharger l'encre d'une tête d'enregistrement (11, 111, 211) portée par un appareil d'enregistrement à jets d'encre, comprenant l'étape qui consiste
à prévoir des parties de positionnement (14, 14-1, 14-2, 114-1, 114-2, 214) pouvant être utilisées pour positionner lesdits orifices de décharge par rapport audit appareil d'enregistrement par jets d'encre, et
caractérisé par
la formation desdites ouvertures (13, 113, 213, 230) et desdites parties de positionnement (14, 14-1, 14-2, 114-1, 114-2, 214) simultanément, dans des positions relatives prédéterminées, par photolithographie.

2. Procédé pour produire une plaque (12, 112, 212) à orifices selon la revendication 1,
caractérisé en ce que
lesdites parties de positionnement (14, 14-1, 14-2, 114-1, 114-2, 214) sont prévues dans des parties de ladite plaque (12, 112, 212) à orifices qui font saillie du corps de ladite tête d'enregistrement (11, 111, 211).

3. Procédé pour produire une plaque (12, 112, 212) à orifices selon l'une des revendications 1 et 2,
caractérisé en ce que
lesdites parties de positionnement (14, 14-1, 14-2, 114-1, 114-2, 214) sont prévues à des extrémités opposées de ladite plaque (12, 112, 212) à orifices entre lesquelles les orifices de décharge sont interposés.

4. Procédé pour produire une plaque (12, 112, 212) à orifices selon l'une quelconque des revendications 1 à 3,
caractérisé en ce que
les formes des parties de positionnement (14, 14-1, 14-2, 114-1, 114-2, 214) diffèrent les unes des autres.

5. Procédé pour produire une plaque (12, 112, 212) à orifices selon l'une quelconque des revendications 1 à 4,
caractérisé en ce que
lesdites parties de positionnement (14, 14-1, 14-2, 114-1, 114-2, 214) sont prévues en tant que parties découpées.

6. Procédé pour produire une plaque (12, 112, 212) à orifices selon l'une quelconque des revendications 1 à 5,
caractérisé en ce que
lesdites parties de positionnement (14, 14-1, 14-2, 114-1, 114-2, 214) sont prévues en

tant que trous traversants.

7. Procédé pour produire une plaque (12, 112, 212) à orifices selon l'une quelconque des revendications 1 à 6,
caractérisé en ce que
lesdites ouvertures (113, 213) sont prévues en forme de fentes.

8. Procédé pour produire une plaque (12, 112, 212) à orifices selon l'une quelconque des revendications 1 à 7,
caractérisé en ce que
lesdites ouvertures (13, 113, 213, 230) sont prévues de façon à correspondre à plusieurs éléments (117, 217) de génération d'énergie de décharge.

9. Procédé pour produire une plaque (12, 112, 212) à orifices selon l'une quelconque des revendications 1, à 8,
caractérisé en ce que
lesdits orifices de décharge sont en outre pourvus d'un élément (119, 121, 219, 221) à paroi de trajet positionné au-dessous de la plaque (12, 112, 212) à orifices.

FIG.1A

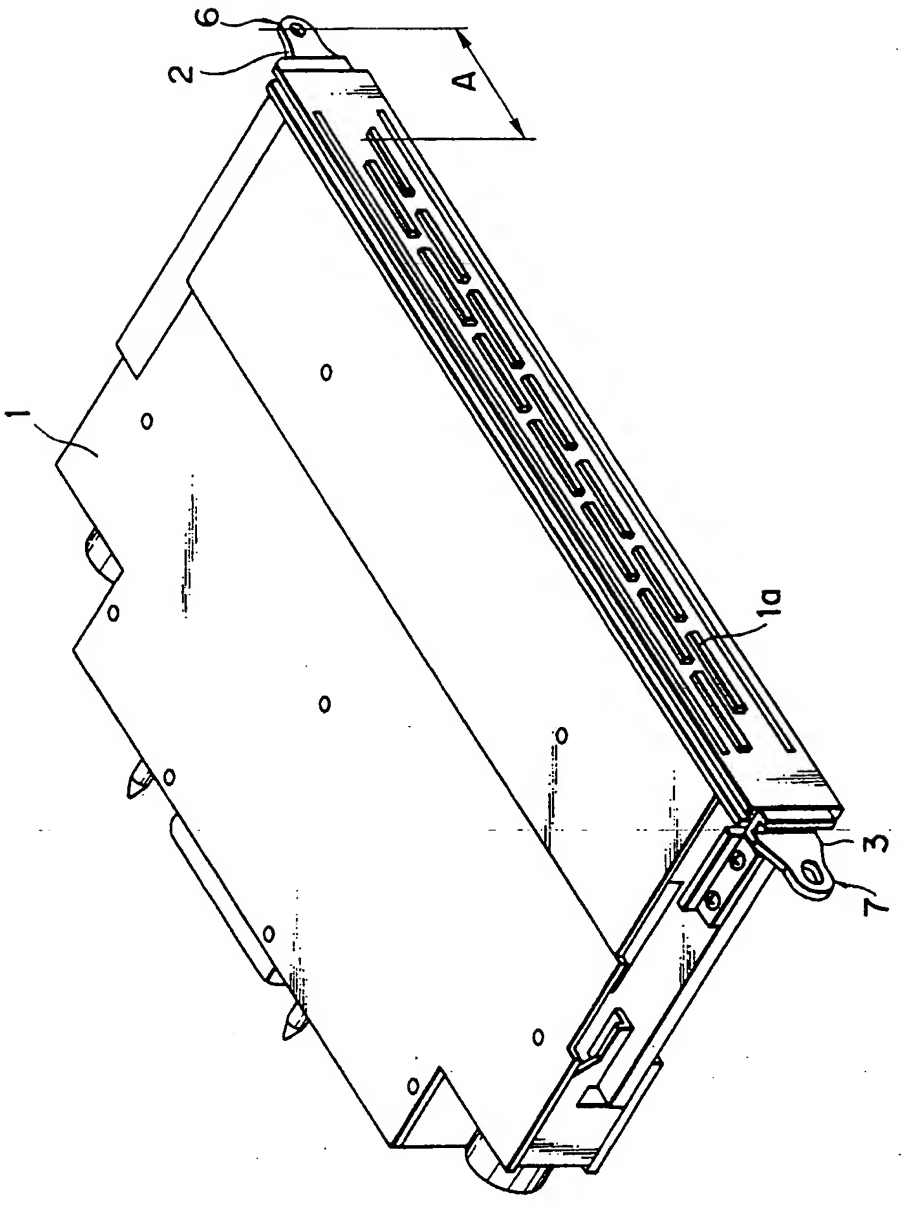

FIG. 1B

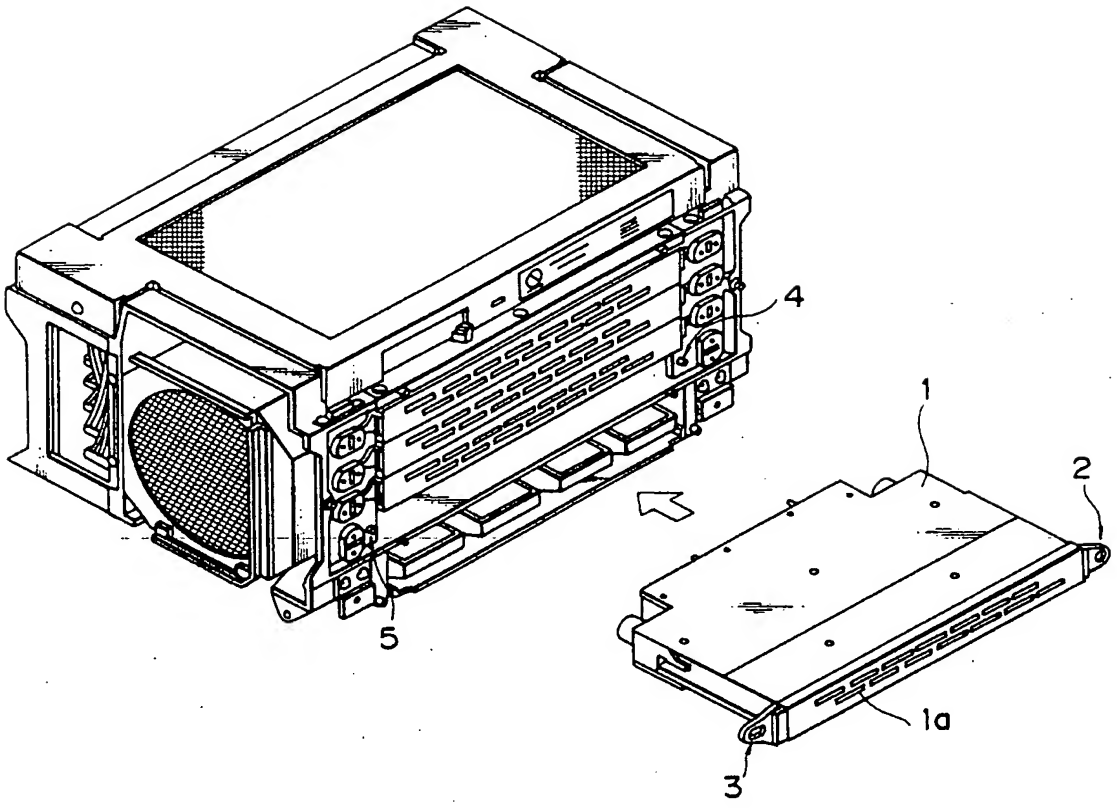

FIG.2

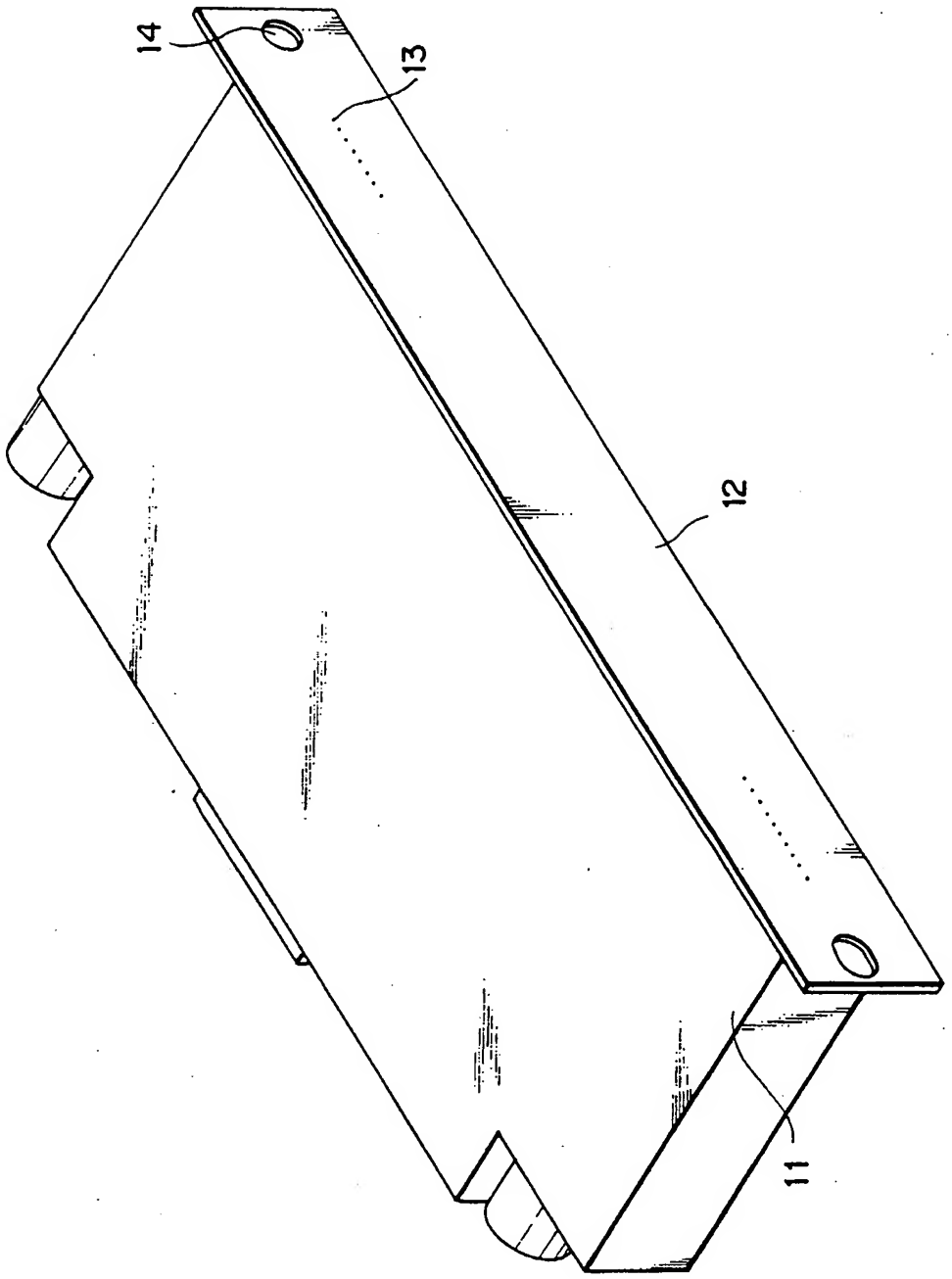

FIG. 3A

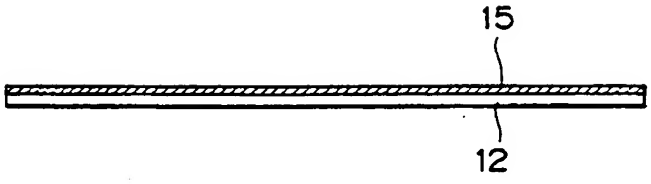

FIG. 3B

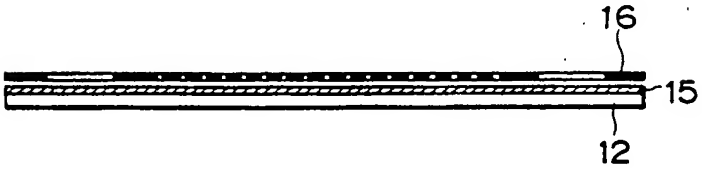

FIG. 3C

FIG. 3D

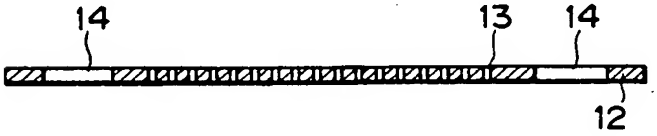

FIG.4

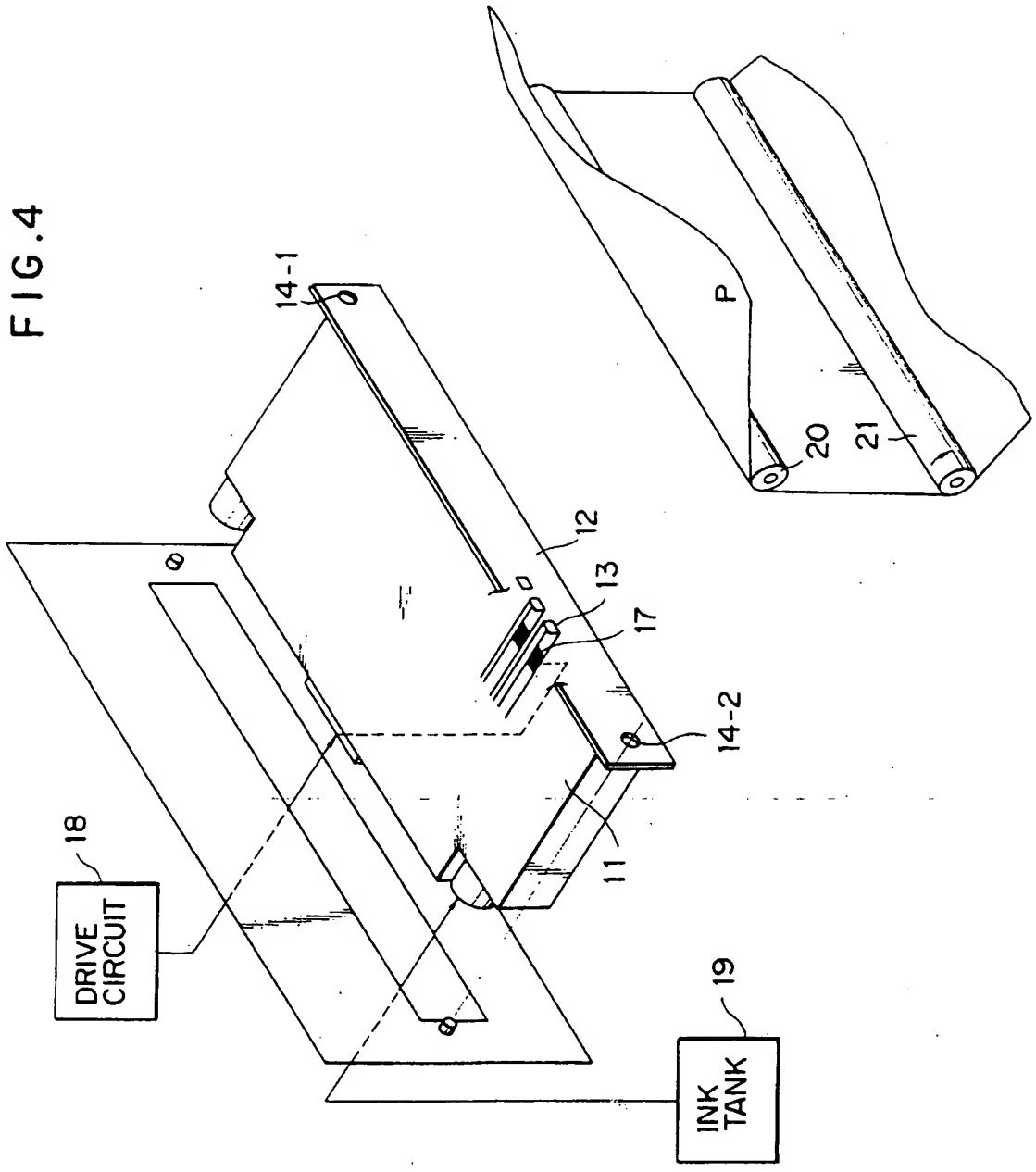

FIG.5

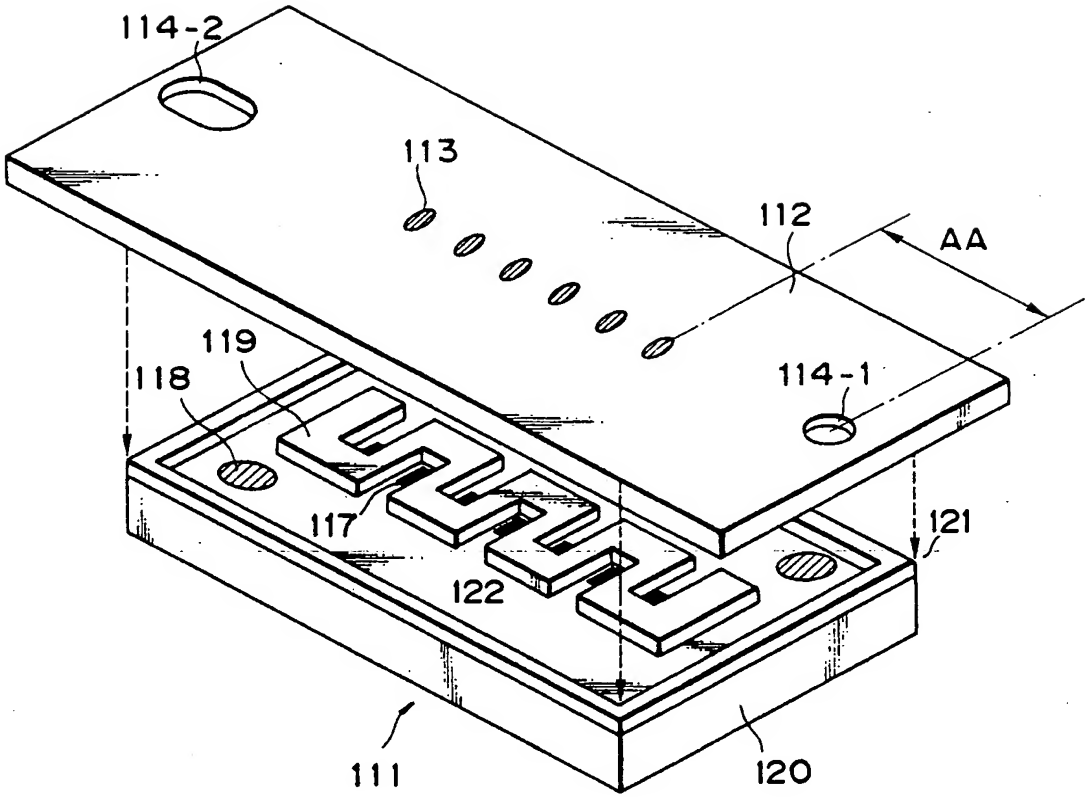

FIG.6